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Applicant HAMUNEN, Antti et al	

1. The designated Office is hereby notified of its election made:

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27 November 2000 (27.11.00)

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INTERNATIONAL SEARCH REPORT

Int[illegible]ional Application No
PCT/IB 00/00543

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C07J9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C07J C11B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ, WPI Data, PAPERCHEM, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category '	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 99 16785 A (UNION CAMP CORP) 8 April 1999 (1999-04-08) whole document, in particular claims 1,3 and 14	1-20
Y	US 4 076 700 A (HARADA TETSUYA ET AL) 28 February 1978 (1978-02-28) claim 2	1-20
Y	US 3 887 537 A (HARADA TETSUYA ET AL) 3 June 1975 (1975-06-03) example 2	1-20
Y	US 2 530 810 A (R. M. CHRISTENSEN ET AL) 21 November 1950 (1950-11-21) column 2, paragraph 3; example IX column 7, paragraphs 1,4 column 10, paragraph 2	1-20

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
12 July 2000	25/07/2000

Name and mailing address of the ISA	Authorized officer
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3 691 211 A (JULIAN DONALD V) 12 September 1972 (1972-09-12) examples IA,IIA	1-20
Y	US 4 254 024 A (STEWART JOHN M ET AL) 3 March 1981 (1981-03-03) claims 12,13,25,26	1-20
P,Y	WO 99 42471 A (B C CHEMICALS LTD ;MACMILLAN ANGUS KIRKE (CA); WONG ALFRED (CA); N) 26 August 1999 (1999-08-26) whole document, in particular claim 1	1-20

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Int [redacted] al Application No
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9916785 A	08-04-1999	AU 9667398 A	23-04-1999
US 4076700 A	28-02-1978	JP 52039613 A	28-03-1977
		JP 55044120 B	10-11-1980
		CA 1050967 A	20-03-1979
		DE 2642414 A	07-04-1977
		GB 1536957 A	29-12-1978
		SE 429445 B	05-09-1983
		SE 7610448 A	23-03-1977
		SU 873891 A	15-10-1981
US 3887537 A	03-06-1975	JP 1022248 C	25-11-1980
		JP 50055602 A	15-05-1975
		JP 55012080 B	29-03-1980
		AT 345950 B	10-10-1978
		AT 745874 A	15-02-1978
		CA 1012964 A	28-06-1977
		DE 2445156 A	03-04-1975
		GB 1481567 A	03-08-1977
		NL 7412370 A,B	20-03-1975
		SE 419639 B	17-08-1981
		SE 7411364 A	19-03-1975
US 2530810 A	21-11-1950	NONE	
US 3691211 A	12-09-1972	CA 946375 A	30-04-1974
		US 3840570 A	08-10-1974
US 4254024 A	03-03-1981	NONE	
WO 9942471 A	26-08-1999	AU 2605799 A	06-09-1999

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(54) Title: PROCESS FOR THE PURIFICATION OF STEROLS FROM HYDROCARBON EXTRACTS USING EVAPORATIVE FRACTIONATION

(57) Abstract

A method for separating sterols from neutral substances comprising the sterols, the method comprising: (a) providing a hydrocarbon fraction containing in the neutral substances; (b) optionally washing the hydrocarbon fraction with water; (c) optionally separating the neutral substances from the hydrocarbon; (d) evaporation fractionating the hydrocarbon fraction from step (a) or step (b), or the neutral substances from step (c), to obtain a sterol-rich fraction; (e) dissolving the sterol-rich fraction in a solvent and crystallizing the sterols from the solvent; and (f) separating the obtained sterol crystals from the solvent.

What is claimed is:

1. A method for separating sterols from neutral substances comprising the sterols, the method comprising:

(a) providing a hydrocarbon fraction containing in the neutral substances;

(b) optionally washing the hydrocarbon fraction with water;

(c) optionally separating the neutral substances from the hydrocarbon;

(d) evaporation fractionating the hydrocarbon fraction from step (a) or step (b), or the neutral substances from step (c), to obtain a sterol-rich fraction;

(e) dissolving the sterol-rich fraction in a solvent and crystallizing the sterols from the solvent; and

(f) separating the obtained sterol crystals from the solvent.

2. The method of claim 1, wherein the hydrocarbon fraction is prepared by extracting a soap with a hydrocarbon solvent, and thereafter separating the hydrocarbon phase from the soap phase.

3. The method of claim 2, wherein the extraction is carried out at a temperature of at least 140°C.

4. The method of claim 3, wherein the temperature is between 140_C and 190°C.

5. The method of claim 2, wherein said extracting step is conducted with an

According to one embodiment of this process, the soap is first saponified with an alkali to decompose esters of rosin acid and fatty acid with sterols and other alcohols, and the thus obtained saponification product is subsequently introduced into a thin film evaporator to evaporate and remove water and low boiling unsaponifiables. The product of this stage can again be introduced into the thin film evaporator to evaporate and separate sterols and heavy unsaponifiables. For the production of pure sterols, this proposed process is very complicated. In addition, this proposed process does not use the technique of extracting neutral substances from soaps.

Summary of the Invention

It has now been realized that in order to remove the impurities interfering with sterol crystallization from the extracted neutral substance, it may be necessary to apply various processes/process combinations, depending on the type of impurity to be removed. The unit operations in question connected with this invention include evaporation fractionation of the impurities in the neutral substance, and optionally high temperature water wash of the neutral substances, before the evaporation fractionation.

This invention relates to a method for producing in good yields high quality, high purity sterols, the method comprising extraction of neutral substances from soaps, removal of components interfering with sterol separation from the neutrals (e.g., impurities), and sterol crystallization from the purified neutral substances.

In one aspect of the present invention there is provided a method for the separation of sterols from soaps comprising

preparing a hydrocarbon fraction rich in neutral substances from a soap,

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(71) Applicant *(for all designated States except US)*: STEROL TECHNOLOGIES LTD. [FI/FI]; P.O. Box 101, FIN-21201 Raisio (FI).

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A method for separating sterols from neutral substances comprising the sterols, the method comprising: (a) providing a hydrocarbon fraction containing in the neutral substances; (b) optionally washing the hydrocarbon fraction with water; (c) optionally separating the neutral substances from the hydrocarbon; (d) evaporation fractionating the hydrocarbon fraction from step (a) or step (b), or the neutral substances from step (c), to obtain a sterol-rich fraction; (e) dissolving the sterol-rich fraction in a solvent and crystallizing the sterols from the solvent; and (f) separating the obtained sterol crystals from the solvent.

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PROCESS FOR THE PURIFICATION OF STEROLS FROM HYDROCARBON EXTRACTS USING EVAPORATIVE FRACTIONATION

This application claims priority under 35 USC § 119(e) of U.S. Provisional Application Serial No. 60/131,303, which is hereby incorporated by reference.

Field of the Invention

The present invention relates to a purification method, and more particularly to an improved method for separation of commercially important sterols from neutral substances or refined neutral substances, which have been separated from soaps.

Background of the Invention

Sterols useable in pharmaceuticals and foods need to be purified to quite a high degree to exclude undesired components, such as inorganic salts and soap residues existing in the neutral substances. Although usually present in low concentrations, a part of these impurities usually tend to remain in the sterol fraction, if the isolation of sterols has been performed by known straight crystallization processes without any particular purification steps. The neutral substances in most cases also contain organic impurities, which usually makes direct crystallization of sterols in pure form difficult. One kind of impurity is a group of compounds which typically cannot be seen in gas chromatographic analyses usually used in sterol assays. The exact nature of these compounds is not known, but there is some evidence that this group consists of a wide molecular weight range hydrocarbon-type material. Because of its invisibility in gas chromatographic analysis, the material is often called "non-elutable compounds" or "nonelutables". Also the lighter components of the neutral substances may sometimes interfere with the crystallization of sterols. In a typical case, when the neutral substances are originated from wood pulping, this

light fraction typically consists of impurities such as di- and sesquiterpene compounds, stilbenes and wax alcohols.

Sterols have previously been crystallized from sterol containing materials, typically from neutral substances, using alcohol, ketone or hydrocarbon solvents, without or with water (U.S. 2,704,764, U.S. 2,729,655, U.S. 2,843,610, U.S. 5,117,016, U.S. 4,420,427). None of these methods work quite satisfactorily in the most usual cases where the substance that contains sterols also contains the impurities noted above.

U.S. 2,870,176 discloses a method of obtaining stigmasterol from a phytosterol solution in which a phytosterol sample is dissolved in hexane and a stigmasterol-enhanced fraction is crystallized from the cooled solution. After separation from the hexane solvent, the stigmasterol-enhanced fraction is redissolved in hexane and recrystallized several times, to obtain substantially pure stigmasterol crystals. There is no disclosure of a step whereby any impurities are separated from the phytosterol fraction.

U.S. 3,965,085 discloses a method for extracting neutral substances from soaps in which a hydrocarbon solvent is used to extract the neutral substances, and thereafter the neutral substance solution phase is evaporated whereby a residue is obtained containing mainly sterols, terpene alcohols, hydrocarbons and other unsaponifiable substances. This solution is cooled to obtain crystalline material. The crystalline material contains sterols, along with fatty alcohols and terpene alcohols. There is no disclosure of a purification method for purifying the sterol crystals. In addition the method does not include any evaporation fractionation step.

U.S. 4,076,700 discloses a process for recovering fatty acids and/or rosin acids and optionally sterols from a tall oil skimming soap or a tall oil soap.

According to one embodiment of this process, the soap is first saponified with an alkali to decompose esters of rosin acid and fatty acid with sterols and other alcohols, and the thus obtained saponification product is subsequently introduced into a thin film evaporator to evaporate and remove water and low boiling unsaponifiables. The product of this stage can again be introduced into the thin film evaporator to evaporate and separate sterols and heavy unsaponifiables. For the production of pure sterols, this proposed process is very complicated. In addition, this proposed process does not use the technique of extracting neutral substances from soaps.

Summary of the Invention

It has now been realized that in order to remove the impurities interfering with sterol crystallization from the extracted neutral substance, it may be necessary to apply various processes/process combinations, depending on the type of impurity to be removed. The unit operations in question connected with this invention include evaporation fractionation of the impurities in the neutral substance, and optionally high temperature water wash of the neutral substances, before the evaporation fractionation.

This invention relates to a method for producing in good yields high quality, high purity sterols, the method comprising extraction of neutral substances from soaps, removal of components interfering with sterol separation from the neutrals (e.g., impurities), and sterol crystallization from the purified neutral substances.

In one aspect of the present invention there is provided a method for the separation of sterols from soaps comprising

preparing a hydrocarbon fraction rich in neutral substances from a soap,

optionally washing the hydrocarbon fraction with water,

optionally separating the hydrocarbon and the neutral substances,

evaporation fractionating the hydrocarbon fraction from step (a) or (b) or the neutral substances from step (c) to obtain a sterol-rich fraction,

dissolving the sterol rich fraction in a solvent system and crystallizing the sterols from the solvent system, and

separating the obtained sterol crystals from the solvent.

The separated sterol product obtained by the method according to the present invention contains practically only sterol components derived from the neutral substance, without any interfering salt or organic impurities, which would make crystallization purification difficult. A further advantage of the method according to this invention is that, in addition to the high purity, simultaneously very high sterol yields are obtained.

Description of the Preferred Embodiments

The neutral substances (unsaponifiables or neutrals) can be obtained by extracting from soaps. Any soap of vegetable origin may be used. Neutral substances suitable as raw material in the method according to the present invention may therefore be obtained from extracts of vegetable origin such as soaps from vegetable oils, or preferably from crude soap from the sulfate cellulose process or pitch soap obtained from tall oil. The method according to the present invention is preferably suitable for neutral substances obtained from soap originated from wood pulping.

The neutral substances can be obtained from soaps typically by extraction. Extraction of these neutral substances from soaps can be performed, for example, by using hydrocarbon solvents at elevated temperatures and pressures,

or using mixtures of hydrocarbons and ketones and/or lower alcohols as extraction solvents (for example, as shown in U.S. 3,965,085, hereby incorporated by reference).

Preferably the hydrocarbon fraction which is rich in neutral substances is prepared by extracting the soap with a hydrocarbon solvent followed by the separation of the hydrocarbon phase from the soap phase. If only hydrocarbon is used as a solvent, the extraction may preferably be performed at elevated temperatures (optionally at elevated pressures, as well) in order to break the emulsion which may otherwise be formed.

Preferably the hydrocarbon extraction of the soap is a high temperature extraction wherein the temperature preferably is at least 140°C, and more preferably between 140°C and 190°C. If the extraction is conducted in a closed system, as preferred, the pressure in the system is at least equal to the vapor pressure of the extraction mixture at the temperature used for extraction.

Typical extraction conditions are, for example: the hydrocarbon used as extraction solvent is heptane, the solids content in the soap to be extracted is about 25-40%; the amount of the solvent used in the extraction is more than one part per one part of dry soap by weight; the extraction temperature is higher than 140 °C; and the pressure is more than 10 bars. The extraction can be performed by using any known extraction method (batch extraction, column, mixer-settler, etc.).

In the extraction, the weight ratio of soap in dry weight : water of the extraction mixture : hydrocarbon solvent of the extraction mixture can be 1 : >1 : >1, preferably 1 : 1-3 : 2-6, more preferably 1 : 2-3 : 3-6, and most preferably 1 : 2-3 : 4-5.

Preferably the washing step (b) is a high temperature water wash

conducted in a closed system, wherein the temperature preferably is between 120°C and 190°C and the pressure is preferably the pressure prevailing at that temperature. Preferably the water wash is done directly after the high temperature hydrocarbon extraction of the soap (if this technique is applied for producing the neutral substance). Approximately the same temperature and pressure conditions can be applied in the extraction step and the washing step.

By the high temperature water wash, traces of inorganic salts and soap residues can be removed. These impurities typically exist only in low concentrations, but give the sterol product an ugly gray or brownish color, if the product is crystallized without removing them. The soaps present in the neutrals usually also make filtration of the crystallized sterols difficult. The high temperature water wash of neutrals has preferably to be performed in a closed system at high temperature (e.g., about 140°C or higher) and high pressure (e.g., above the prevailing pressure at the water temperature), if there is any tendency of emulsion formation during the wash. The amounts of water to neutral substance (hydrocarbon) phase may vary in a broad range; e.g. weight ratios from 1:10 to 10:1 can be applied depending on the amount of impurities included. It has been shown that the water wash removes only undesired impurity components, and practically does not affect the sterol content of neutral substances.

Neutral substances can be separated from the hydrocarbon phase by evaporating the same to dryness, filtration or centrifuging, as well known in the art.

Evaporation fractionation of impurities can be applied in connection with the water wash, or it can be used instead of it. By using short path distillation (e.g. thin film or wiped film) the components lighter than sterols can be

removed, leaving the sterol-rich fraction as the bottom fraction. The typical applicable conditions are, for example, 0.1 mbar pressure and 160°C temperature. The time is not critical, and can be as little as several seconds, as the evaporation step is normally continuous. The evaporation removes, for example, diterpene compounds, stilbenes and wax alcohols interfering the subsequent crystallization of sterols. The removal of these components can further be improved by using a rectification column in connection with the short path evaporation.

The content of these impurities in typical neutral substances originated e.g. from wood pulping, may be up to 30-40%. The sterols can be crystallized from the evaporation bottoms. The advantage is that because of increased sterol content in the thus refined neutral substance and removal of interfering components, the yield and the purity of the sterol product will be better than without evaporation fractionation. However, this type of evaporation in most cases does not remove all of the inorganic salts and soap residues. Thus, to obtain still better results, it is advantageous to combine the evaporation fractionating step with the high temperature (and preferably, high pressure) water wash pretreatment.

The evaporation fractionation of the neutral substance can also be implemented so that the sterol-rich fraction is evaporated and accordingly separated from the heaviest components of the neutral substance. In this case, inorganic salts and soap residues will also be separated from the sterol fraction. Thus, no separate water wash procedure is needed in this case. Evaporation of the light fraction can be a preceding part of the evaporation of the sterol fraction in order to most efficiently fractionate the interfering impurity components. Typical conditions for evaporation of the sterol rich fraction are e.g. pressure

0.1 mbar, temperature 220°C, time as indicated above. It has been shown that the sterols contained in the evaporation feed can be recovered practically quantitatively to the distillate when having proper distillation conditions. Thus, no significant sterol losses will take place during this purification step. Taking into account that the sterol content in the sterol-rich fraction during evaporation fractionation can be increased typically from 25-30% content in the original neutral substance to over 40-60% in the fractionated sterol-rich distillate fraction, and this taking place without any substantial sterol losses, it is clear that this purification offers a very good starting point for the crystallization purification step of sterols.

Crystallization of the sterols from the sterol-rich fraction can be performed by using any known solvent or solvent combination. However, particularly advantageous is to use hydrocarbons combined with water, or even more preferably may be the use of combinations of hydrocarbons, water and a lower (C_1-C_6) alkanol, especially methanol.

Preferably the hydrocarbon solvent used in this invention is a short chain, aliphatic or cycloaliphatic hydrocarbon containing 1-10 carbon atoms, preferably 5-8 carbon atoms. Preferred hydrocarbon solvents are hexane, heptane, octane, cyclohexane, methylcyclohexane and mixtures thereof.

In the crystallization solvent system the weight ratio of hydrocarbon : lower alkanol : water is preferably 1.5-5 : 0-0.5 : 0-1, and more preferably 1.5-3.5 : 0.03-0.035 : 0-1.

In the crystallization step, the weight ratio of the sterol-rich fraction in dry weight : solvent system is preferably 1 : 1.5-6.5, and more preferably 1 : 1.5-5.

After the crystallization step, the sterol crystals are preferably washed

with any suitable solvent or solvent system, preferably with a solvent system which is the same as the crystallization solvent system.

The following examples illustrate the invention in more detail. The %-figures mean % by weight. The term purity means the content of identified sterol components. The sterol product contains also small amounts of probably closely related, but not exactly identified, sterol-like components, which behave like the sterols in question and cannot be removed using these processes. Thus, the maximum purity practically attainable by these purification processes is about 98%.

Example 1

The unsaponifiables (from *Pinus taeda* based pitch soap) used in this crystallization were in a hydrocarbon solvent (a mixture of aliphatic and cycloaliphatic hydrocarbons, LIAV110 delivered by Neste Oy). The mixture of solvent and unsaponifiables was brought directly from the soap extraction, which was performed at 170°C and 18 bar pressure in a pressure autoclave. The material ratios of the components were 1 part dry soap, 2 parts water and 4 parts solvent. After 5 minutes at extraction temperature mixing was stopped and the layers were allowed to separate. The lower water phase was separated through a cooled sampling bomb when the contents were still hot. Solids content in the remaining hydrocarbon phase was 11.3%, and the sterol content was 35% of the solids. The hydrocarbon phase was allowed to cool slowly to 20°C. The precipitated sterols were filtered and washed with fresh solvent. From 100 g of dry neutrals 22.5 g of a sterol blend was obtained, consisting of sitosterol, sitostanol, campesterol and campestanol and nonelutable impurities. The color of the product was light grey/brown. The ash content describing the amount of

inorganic salts was 0.4%. The sterol content was 80%.

Example 2

10 l of the hydrocarbon phase of example 1 was put into an autoclave and 5 l water was added. The autoclave was closed and the temperature was raised to 130°C simultaneously stirring the contents. After 5 minutes at 130°C the stirring was stopped and the lower water phase was separated through a water cooled sampling bomb. The hydrocarbon phase was let to cool to 20°C. The crystallized material was filtered and washed with fresh hydrocarbon. The color of the resulting crystalline crude sterol was white and the ash content was 0.09%. The purity of the sterols was 82% and the yield 23 g/100 g feed neutral substance.

Example 3

This example is a reference example for crystallization of sterols from unsaponifiables using a hydrocarbon/methanol/water mixture as crystallization solvent without any other refining processes.

A sample of dried *Pinus radiata* unsaponifiables, which were produced by hexane-acetone extraction (e.g. according to U.S. 3,965,085), were dissolved into a LIAV110/methanol/water solvent mixture in ratios 1/3/0.3/0.1 (by weight) by heating to boiling temperature. Sterols were crystallized by cooling the temperature slowly to 25°C, and separated by filtration using a Buchner funnel. Washing was accomplished with a pure crystallization solvent mixture in small portions, the amount and content of it being the same as in the crystallization step. The yield of dried product was 73%, purity 93% and ash content 0.35%.

Example 4

Pinus radiata unsaponifiables extracted using a commercial hexane-acetone extraction (solvent content 5%) were dried from residual solvents using short path evaporation (the equipment was the wiped film evaporator KDL-5, manufactured by UIC). The conditions were: pressure 10 mbar and evaporator temperature 150°C in the jacket of the equipment. The solvent free neutrals were led to the wiped film evaporator to remove the light neutrals fraction. The conditions in this unit were: pressure 0.1 mbar and temperature 160°C. The distillate (30% of the feed), which contains light neutrals, contained 3% of the original sterol content of the feed. A sample of the bottom fraction from this distillation (sterol content about 46%) was dissolved by refluxing in LIAV110/methanol/water (3:0.3:0.1, 1 part of the bottom fraction (dry weight) /3.4 parts of solvent) and the sterol fraction was crystallized by cooling the mixture slowly to 25°C. After similar separation procedures as in example 3, the sterol yield recovered was 79% of the sterol content in the original neutral substance and the sterol purity was 96.5%. The ash content in the sterol product was 0.37%.

Example 5

The rest of the bottom fraction from the distillation performed in Example 4 was fed again to the wiped film evaporator. Now the evaporation conditions were: pressure 0.1 mbar, temperature 225°C. 95% sterols of the feed were recovered to the distillate, where the sterol concentration was 51%.

A sample of the distillate was dissolved in a LIAV110:MeOH:water blend in the same ratios as in Example 4 (1:3:0.3:0.1). After crystallization, filtration separation and washing with a solvent similar to the crystallization solvent, the

yield of dried sterol was 83% of the sterol content in the distillate and the purity was 97.5%. The color of the product was very white and ash content was only 0.01%.

Example 6

Another sample of the distillate prepared in Example 5 was dissolved in a LIAV110/water mixture in ratios distillate:LIAV:water 1:7:1. The crystallization procedure was as in the previous examples. The yield of dried sterols was 77% and the purity was 97.5%.

Example 7

The neutral substance was prepared and washed as in example 2. The solvents were removed by using a rotavapor. The light fraction was removed from the dried neutrals by evaporating with a KDL-5 wiped film evaporator (0.1 mbar, 163°C temperature in the jacket). The yield of the light fraction was 32%, and the total sterol loss to the light fraction was 4%. A sample of the distillation residue was dissolved, crystallized and separated from a LIAV/methanol/water solvent and washed as in example 4. The sterol yield was 80% and the purity was 97.5%. Ash content of the almost white product was 0.1%.

Example 8

The feed material was *Pinus radiata* wood based unsaponifiables extracted by hexane-acetone solvent extraction. The dried unsaponifiables were fed to a wiped film evaporator equipped with a rectification column. The temperature of the feed neutrals was 150°C, the temperature in the bottom part of the column was 207°C, in the top part of the column 189 °C, and in the

residue 241°C (the jacket temperature was 298°C). The pressure inside the equipment was 2.2 mmHg. The amount of light fraction distilled over was 23% and the amount of residue was 76%. The sterol loss into the light fraction was only 0.4%. Sterol content in the residue was 48.1 %.

The residue from this distillation was fed into a short path distillation equipment. The conditions there were: pressure 0.1 mmHg, feed temperature 149°C, jacket temperature 312°C, condenser temperature 112°C, temperature of residue 184°C. The sterol yield of the distillate in this evaporation was 95% of the feed mass (residue 5% of the feed). The sterol concentration in the distillate was 51.5%, and in the residue 9%. The loss of sterols in this distillation was only 1%.

A sample of the distillate was dissolved in a LIAV110/methanol/water solvent and sterols were crystallized, separated and washed with a solvent similar to the one used in the crystallization, as in previous examples. The sterol yield was 83% and the purity was 97.8%. Ash content of the product was 0.01%.

What is claimed is:

1. A method for separating sterols from neutral substances comprising the sterols, the method comprising:

(a) providing a hydrocarbon fraction containing in the neutral substances;

(b) optionally washing the hydrocarbon fraction with water;

(c) optionally separating the neutral substances from the hydrocarbon;

(d) evaporation fractionating the hydrocarbon fraction from step (a) or step (b), or the neutral substances from step (c), to obtain a sterol-rich fraction;

(e) dissolving the sterol-rich fraction in a solvent and crystallizing the sterols from the solvent; and

(f) separating the obtained sterol crystals from the solvent.

2. The method of claim 1, wherein the hydrocarbon fraction is prepared by extracting a soap with a hydrocarbon solvent, and thereafter separating the hydrocarbon phase from the soap phase.

3. The method of claim 2, wherein the extraction is carried out at a temperature of at least 140°C.

4. The method of claim 3, wherein the temperature is between 140_C and 190°C.

5. The method of claim 2, wherein said extracting step is conducted with an

extraction mixture comprising the soap, the hydrocarbon solvent and water, which are present in the extraction mixture at a weight ratio of 1 : >1 : >1.

6. The method of claim 5, wherein the soap, the hydrocarbon solvent and the water are present in the extraction mixture at a weight ratio of 1 : 1-3 : 2-6.

7. The method of claim 5, wherein the soap, the hydrocarbon solvent and the water are present in the extraction mixture at a weight ratio of 1 : 2-3 : 3-6.

8. The method of claim 5, wherein the soap, the hydrocarbon solvent and the water are present in the extraction mixture at a weight ratio of 1 : 2-3 : 4-5.

9. The method of claim 1, wherein the washing step (b) is carried out at a temperature between 120°C and 190°C.

10. The method of claim 1, wherein the evaporation fractionating step (d) is carried out at such conditions that the sterol-rich fraction is obtained as a bottom fraction.

11. The method of claim 1, wherein the evaporating fractionating step (d) is carried out at such conditions that the sterol-rich fraction is obtained as a distillate.

12. The method of claim 1, wherein the hydrocarbon in the hydrocarbon fraction is selected from the group consisting of hexane, heptane, octane, cyclohexane, methylcyclohexane and mixtures thereof.

13. The method of claim 1, wherein the solvent is selected from the group consisting of a hydrocarbon, a C_1-C_6 alkanol, water and mixtures thereof.

14. The method of claim 13, wherein the C_1-C_6 alkanol is methanol.

15. The method of claim 13, wherein the solvent is a mixture of the hydrocarbon, the C_1-C_6 alkanol and the water, in a weight ratio of 1.5-5 : 0-0.5 : 0-1.

16. The method of claim 15, wherein the weight ratio is 1.5-3.5 : 0.03-0.35 : 0-1.

17. The method of claim 1, wherein in step (e) the sterol-rich fraction and the solvent are present in a weight ratio of 1 : 1.5-6.5, based on the dry weight of the sterol-rich fraction.

18. The method of claim 17, wherein the weight ratio is 1 : 1.5-5.

19. The method of claim 1, comprising the further step of washing the sterol crystals after the crystallizing step (e).

20. The method of claim 19, wherein the crystals are washed with a solvent which is the same as the solvent used in step (e).

INTERNATIONAL SEARCH REPORT

Int[redacted]al Application No
PCT/IB 00/00543

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C07J9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C07J C11B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ, WPI Data, PAPERCHEM, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 99 16785 A (UNION CAMP CORP) 8 April 1999 (1999-04-08) whole document, in particular claims 1,3 and 14	1-20
Y	US 4 076 700 A (HARADA TETSUYA ET AL) 28 February 1978 (1978-02-28) claim 2	1-20
Y	US 3 887 537 A (HARADA TETSUYA ET AL) 3 June 1975 (1975-06-03) example 2	1-20
Y	US 2 530 810 A (R. M. CHRISTENSEN ET AL) 21 November 1950 (1950-11-21) column 2, paragraph 3; example IX column 7, paragraphs 1,4 column 10, paragraph 2	1-20

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 July 2000	25/07/2000

Name and mailing address of the ISA	Authorized officer
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Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Int[redacted]al Application No
PCT/IB 00/00543

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3 691 211 A (JULIAN DONALD V) 12 September 1972 (1972-09-12) examples IA,IIA	1-20
Y	US 4 254 024 A (STEWART JOHN M ET AL) 3 March 1981 (1981-03-03) claims 12,13,25,26	1-20
P,Y	WO 99 42471 A (B C CHEMICALS LTD ;MACMILLAN ANGUS KIRKE (CA); WONG ALFRED (CA); N) 26 August 1999 (1999-08-26) whole document, in particular claim 1	1-20

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int[illegible]al Application No
PCT/IB 00/00543

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9916785 A	08-04-1999	AU 9667398 A	23-04-1999
US 4076700 A	28-02-1978	JP 52039613 A	28-03-1977
		JP 55044120 B	10-11-1980
		CA 1050967 A	20-03-1979
		DE 2642414 A	07-04-1977
		GB 1536957 A	29-12-1978
		SE 429445 B	05-09-1983
		SE 7610448 A	23-03-1977
		SU 873891 A	15-10-1981
US 3887537 A	03-06-1975	JP 1022248 C	25-11-1980
		JP 50055602 A	15-05-1975
		JP 55012080 B	29-03-1980
		AT 345950 B	10-10-1978
		AT 745874 A	15-02-1978
		CA 1012964 A	28-06-1977
		DE 2445156 A	03-04-1975
		GB 1481567 A	03-08-1977
		NL 7412370 A,B	20-03-1975
		SE 419639 B	17-08-1981
		SE 7411364 A	19-03-1975
US 2530810 A	21-11-1950	NONE	
US 3691211 A	12-09-1972	CA 946375 A	30-04-1974
		US 3840570 A	08-10-1974
US 4254024 A	03-03-1981	NONE	
WO 9942471 A	26-08-1999	AU 2605799 A	06-09-1999

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

Received
PCT AUG 1 2001

To:

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NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL PRELIMINARY
EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing *(day/month/year)*	19.07.2001

Applicant's or agent's file reference	IMPORTANT NOTIFICATION
023406.00002	

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/IB00/00543	27/04/2000	27/04/1999

Applicant
STEROL TECHNOLOGIES LTD. et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Neubauer, M Tel.+49 89 2399-7272

Form PCT/IPEA/416 (July 1992)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
023406.00002		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/IB00/00543	27/04/2000	27/04/1999
International Patent Classification (IPC) or national classification and IPC C07J9/00		
Applicant STEROL TECHNOLOGIES LTD. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 2 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☒ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
27/11/2000	19.07.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Friebel, F Telephone No. +49 89 2399 8552

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IB00/00543

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1,2,4-13	as originally filed	
3	with telefax of	02/07/2001

Claims, No.:

5 (part),6-20	as originally filed	
1-4,5 (part)	with telefax of	02/07/2001

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   - ☐ the description, pages:
   - ☐ the claims, Nos.:
   - ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-20
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-20
Industrial applicability (IA)	Yes:	Claims	1-20
	No:	Claims	

2. Citations and explanations
   see separate sheet

VI. Certain documents cited

1. Certain published documents (Rule 70.10)

and / or

2. Non-written disclosures (Rule 70.9)

   see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

the IPER, the

point V:

Examiner noted that the application

What is claimed is a method for separating sterols from neutral substances. This method which starts from a hydrocarbon fraction containing the neutral substances. This hydrocarbon fraction is subjected to a so-called evaporation fractionating step. (remove underline) Prior to said fractionation, however, the sterol containing fraction is freed from any hydrocarbon solvent (in response to the W.O. the Applicant deleted 'optional' from step c). Furthermore, there may be performed a washing treatment (see step b. After evaporation fractioning there is obtained a sterol rich fraction which is dissolved in a solvent and and the sterol is crystallized therefrom.

The Examiner stated that the closest

closest prior art is the document **US 2530810 (D1)** which discloses the following combination of process features:

Patent No. hereinafter "D1"; (remove underline) of the '810 patent"

(1) sterol containing hydrocarbon fraction

(2) evaporation fractioning

(3) crystallisation

Examiner's attention was drawn

The Applicant's attention is for instance directed to the end of Expl.IX in col. 6 of the '810 patent (D1) which is relavant to the sequence: hydrocarbon fraction of sterols ➡ evaporation to separate the neutral substances ➡ crystallization.

The Examiner characterized the

In his response to the W.O. the Applicant stressed written opinion as stressing that according to this prior art process the solvent is evaporated and the neutral substances are not fractionated in the evaporation step. However, from **WO 99/16785 (D2)** it is already known that sterols and solvent may be separated by destillation (see the Fig.3 and the examiner has retrieved this by citing to from which follow the solvent extract phase (stream 22) which originates from the first stage separator 302 and is sent to the still 310.)

the '810 patent's

in particular,

The Examiner also cited to the '810 patent for the following disclosures:

Further pertinent parts of the D1 reference are:

- as concerns the preferred hydrocarbon solvents, see the last paragraph of col.5, of the '810 patent
- the washing step is mentioned in the 1st paragraph of col.7, of the '810 patent
- the conditions for crystallization are given in the 4th paragraph of col 7 of the '810 patent, and
- as concerns the temperatures applied, see the 2nd paragraph of col.10 of the '810 patent.

Examiner, therefore, concluded that the claimed method

The method claimed is therefore deemed to be obvious over D1 taken in combination with D2; Art.33(3) PCT.

point VI:

As concerns the reference WO 99/42471 the IPEA assumes that the present application is entitled to the priority date claimed.

point VIII:

The Examin also noted that claimed which ed

As concerns the type of solvent used to provide the starting solution, containing the neutral substances the claims are not in line with the description. Claim 1 speaks explicitly of a hydrocarbon fraction (see also Claim 12) whereas the description is much broader in that it refers also to ketons and/or lower alcohols; see the paragraph bridging pages 4/5 of the description and the examples. When entering into the reg./nat. phase this discrepancy should be eliminated (Art.6 PCT).

→ The Examiner Stated that

What is claimed i

1. A method for separating sterols from the neutral substances comprising the sterols, the method comprising:

(a) providing a hydrocarbon fraction containing the neutral substances;

(b) optionally washing the hydrocarbon fraction with water;

(c) separating the neutral substances from the hydrocarbon;

(d) evaporation fractionating the hydrocarbon fraction from step (a) or step (b), or the neutral substances from step (c), to obtain a sterol-rich fraction.

(e) dissolving the sterol-rich fraction in a solvent and crystallizing the sterols from the solvent; and

(f) separating the obtained sterol crystals from the solvent.

2. The method of claim 1, wherein the hydrocarbon fraction is prepared by extracting a soap with a hydrocarbon solvent, and thereafter separating the hydrocarbon phase from the soap phase.

3. The method of claim 2, wherein the extraction is carried out at a temperature of at least 140°

4. The method of claim 3, wherein the temperature is between 140_C and 190°C.

5. The method of claim 2, wherein said extracting step is conducted with an

According to one embodiment of this process, the soap is first saponified with an alkali to decompose esters of rosin acid and fatty acid with sterols and other alcohols, and the thus obtained saponification product is subsequently introduced into a thin film evaporator to evaporate and remove water and low boiling unsaponifiables. The product of this stage can again be introduced into the thin film evaporator to evaporate and separate sterols and heavy unsaponifiables. For the production of pure sterols, this proposed process is very complicated. In addition, this proposed process does not use the technique of extracting neutral substances from soaps.

In Example IX of U.S. 2,530,810, saponified tall oil residue was further diluted with a mixture of water and isopropyl alcohol. Naphtha was then added to extract unsaponifiable matter. The unsaponifiable matter in the solution was extracted through the addition of naphtha. The naphtha may then be removed from the solution through evaporation. Sterols may then be crystallized out of methyl alcohol.

Summary of the Invention

It has now been realized that in order to remove the impurities interfering with sterol crystallization from the extracted neutral substance, it may be necessary to apply various processes/process combinations, depending on the type of impurity to be removed. The unit operations in question connected with this invention include evaporation fractionation of the impurities in the neutral substance, and optionally high temperature water wash of the neutral substances, before the evaporation fractionation.

This invention relates to a method for producing in good yields high quality, high purity sterols, the method comprising extraction of neutral substances from soaps, removal of components interfering with sterol separation from the neutrals (e.g., impurities), and sterol crystallization from the purified neutral substances.

In one aspect of the present invention there is provided a method for the separation of sterols from soaps comprising

Preparing a hydrocarbon fraction rich in neutral substances from a soap,

AMENDED SHEET

14

PATENT COOPERATION TREATY

PCT

REC'D 23 JUL 2001
WIPO PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
023406.00002		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/IB00/00543	27/04/2000	27/04/1999
International Patent Classification (IPC) or national classification and IPC C07J9/00		
Applicant STEROL TECHNOLOGIES LTD. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

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   - I ☒ Basis of the report
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   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
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   - VII ☐ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
27/11/2000	19.07.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Friebel, F Telephone No. +49 89 2399 8552

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IB00/00543

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1,2,4-13	as originally filed	
3	with telefax of	02/07/2001

Claims, No.:

5 (part),6-20	as originally filed	
1-4,5 (part)	with telefax of	02/07/2001

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   - ☐ the description, pages:
   - ☐ the claims, Nos.:
   - ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-20
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-20
Industrial applicability (IA)	Yes:	Claims	1-20
	No:	Claims	

2. Citations and explanations
   see separate sheet

VI. Certain documents cited

1. Certain published documents (Rule 70.10)

and / or

2. Non-written disclosures (Rule 70.9)

   see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

point V:

What is claimed, is a method for separating sterols from neutral substances which starts from a hydrocarbon fraction containing the neutral substances. This hydrocarbon fraction is subjected to a so called evaporation fractionating step. Prior to said fractionation the sterol containg fraction is freed from any hydrocarbon solvent (in response to the W.O. the Applicant deleted 'optional ' from step c). Furthermore, there may be performed a washing treatment; see step b. After evaporation fractioning there is obtained a sterol rich fraction which is dissolved in a solvent and and the sterol is crystallized therefrom.

Closest prior art is the document **US 2530810 (D1)** which discloses the following combination of process features:

- sterol containing hydrocarbon fraction
- evaporation fractioning
- crystallisation

The Applicant's attention is for instance directed to the end of Expl.IX in col. 6 of D1 which is relavant to the sequence: hydrocarbon fraction of sterols ➡ evaporation to separate the neutral substances ➡ crystallization.

In his response to the W.O. the Applicant stressed that according to this prior art process the solvent is evaporated and the neutral substances are not fractionated in the evaporation step. However, from **WO 99/16785 (D2)** it is already known that sterols and solvent may be separated by destillation, see the Fig.3: follow the solvent extract phase (stream 22) which originates from the first stage separator 302 and is sent to the still 310.

Further pertinent parts of the D1 reference are:

- as concerns the preferred hydrocarbon solvents, see the last paragraph of col.5,
- the washing step is mentioned in the 1st paragraph of col.7,
- the conditions for crystallization are given in the 4th paragraph of col 7,
- as concerns the temperatures applied, see the 2nd paragraph of col.10.

The method claimed is therefore deemed to be obvious over D1 taken in combination with D2; Art.33(3) PCT.

point VI:

As concerns the reference WO 99/42471 the IPEA assumes that the present application is entitled to the priority date claimed.

point VIII:

As concerns the type of solvent used to provide the starting solution containing the neutral substances the claims are not in line with the description. Claim 1 speaks explicitly of a hydrocarbon fraction (see also Claim 12) whereas the description is much broader in that it refers also to ketons and/or lower alcohols; see the paragraph bridging pages 4/5 of the description and the examples. When entering into the reg./nat. phase this discrepancy should be eliminated (Art.6 PCT).

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
023406.00002		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/IB 00/00543	27/04/2000	27/04/1999
Applicant		
STEROL TECHNOLOGIES LTD. et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

[ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

[ ] contained in the international application in written form.

[ ] filed together with the international application in computer readable form.

[ ] furnished subsequently to this Authority in written form.

[ ] furnished subsequently to this Authority in computer readble form.

[ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

[ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

[ ] the text is approved as submitted by the applicant.

[X] the text has been established by this Authority to read as follows:

PROCESS FOR THE PURIFICATION OF STEROLS FROM HYDROCARBON EXTRACTS USING EVAPORATIVE FRACTIONATION

5. With regard to the **abstract,**

[X] the text is approved as submitted by the applicant.

[ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. –

[ ] as suggested by the applicant.

[ ] because the applicant failed to suggest a figure.

[ ] because this figure better characterizes the invention.

[ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No
[redacted]IB 00/00543

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C07J9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C07J C11B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ, WPI Data, PAPERCHEM, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 99 16785 A (UNION CAMP CORP) 8 April 1999 (1999-04-08) whole document, in particular claims 1,3 and 14	1-20
Y	US 4 076 700 A (HARADA TETSUYA ET AL) 28 February 1978 (1978-02-28) claim 2	1-20
Y	US 3 887 537 A (HARADA TETSUYA ET AL) 3 June 1975 (1975-06-03) example 2	1-20
Y	US 2 530 810 A (R. M. CHRISTENSEN ET AL) 21 November 1950 (1950-11-21) column 2, paragraph 3; example IX column 7, paragraphs 1,4 column 10, paragraph 2	1-20

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 July 2000	25/07/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Watchorn, P

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
IB 00/00543

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3 691 211 A (JULIAN DONALD V) 12 September 1972 (1972-09-12) examples IA,IIA	1-20
Y	US 4 254 024 A (STEWART JOHN M ET AL) 3 March 1981 (1981-03-03) claims 12,13,25,26	1-20
P,Y	WO 99 42471 A (B C CHEMICALS LTD ;MACMILLAN ANGUS KIRKE (CA); WONG ALFRED (CA); N) 26 August 1999 (1999-08-26) whole document, in particular claim 1	1-20

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
IB 00/00543

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9916785 A	08-04-1999	AU 9667398 A	23-04-1999
US 4076700 A	28-02-1978	JP 52039613 A	28-03-1977
		JP 55044120 B	10-11-1980
		CA 1050967 A	20-03-1979
		DE 2642414 A	07-04-1977
		GB 1536957 A	29-12-1978
		SE 429445 B	05-09-1983
		SE 7610448 A	23-03-1977
		SU 873891 A	15-10-1981
US 3887537 A	03-06-1975	JP 1022248 C	25-11-1980
		JP 50055602 A	15-05-1975
		JP 55012080 B	29-03-1980
		AT 345950 B	10-10-1978
		AT 745874 A	15-02-1978
		CA 1012964 A	28-06-1977
		DE 2445156 A	03-04-1975
		GB 1481567 A	03-08-1977
		NL 7412370 A,B	20-03-1975
		SE 419639 B	17-08-1981
		SE 7411364 A	19-03-1975
US 2530810 A	21-11-1950	NONE	
US 3691211 A	12-09-1972	CA 946375 A	30-04-1974
		US 3840570 A	08-10-1974
US 4254024 A	03-03-1981	NONE	
WO 9942471 A	26-08-1999	AU 2605799 A	06-09-1999